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Original Research

Damage control surgery and packing in patients with blunt abdominal trauma

Damage control surgery in blunt abdominal trauma

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Abstract

Aim: Blunt abdominal traumas (BAT), which account for a large proportion of traumatic injuries, form a significant proportion of patients in emergency departments and are the leading cause of death in people under 45 years of age. In this study, we aimed to present the results of our patients who were admitted to our emergency department with BAT and underwent packing procedures during damage control laparotomy.

Material and Methods: The patients aged ≥18 years who underwent emergency laparotomy for BAT and underwent packing with damage control surgery between 01.01.2021 and 31.12.2023 in our tertiary care hospital, a level 1 trauma center, were retrospectively analyzed in this study.

Results: Of the15 patients included in the study, 11 (73.3 %) were male. The mean age of the patients was 36.13 ± 1 4.16 years. Traffic accidents and occupational injuries were the most common causes of blunt trauma. The median duration of hospitalization was 14 (1-124) days, and mortality was observed in 3 patients (20%). In 13 patients (87.7%), both ultrasonography and computed tomography imaging were performed. Shock index, Glasgow Coma Scale (GCS), Injury Severity Score (ISS), Revised Trauma Score (RTS), and Trauma and Injury Severity Score (TRISS) values were calculated. The mean ISS was found to be 37.2 ± 9.4.

Discussion: Damage control surgery, which is an essential approach for reducing mortality and morbidity rates in blunt abdominal trauma, remains crucial. The formation of multidisciplinary trauma teams with well-equipped trauma centers is necessary to achieve successful treatment outcomes in trauma patients.

Keywords

Blunt Abdominal Trauma, Damage Control Surgery, Liver Trauma, Trauma Surgery

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Introduction

Traumas are the seventh most common cause of death in the general population and among the most common causes of death in the group under 45 years of age. As the third most common anatomical region affected by trauma, abdominal traumas constitute a significant proportion of patients in emergency departments. Abdominal traumas are classified as penetrating and blunt according to their etiology, and blunt abdominal traumas (BAT) constitute the majority with a rate of 85% [1].

The spleen and liver are the two most common organs injured in blunt abdominal trauma. Intestines, mesentery, pancreas, and retroperitoneal region are other structures that can be injured [2]. Abdominal injuries account for 15-20% of all trauma-related deaths. Mortality rates can be reduced with early intervention in abdominal traumas compared to head and chest traumas, which are more fatal [3]. The approach to trauma should be systematic and prioritized. Damage control surgery (DCS), which includes laparotomy, packing, and rapid wound closure to prevent bleeding and septic foci in order to restore physiological stability in trauma patients with hypothermia, acidosis, and coagulopathy, called the “death triad”, was defined in 1993 [4].

In this study, we aimed to present our perioperative results of packing procedures during damage control laparotomies in a group of patients who were admitted to our emergency department with BAT and were not eligible for nonoperative treatment conditions.

Material and Methods

This retrospective cross-sectional study was conducted in a level one trauma center of a tertiary care training and research hospital. The study included patients aged 18 years and older who were diagnosed with blunt abdominal trauma in the emergency department between 01.01.2021 and 31.12.2023 and underwent packing with damage control surgery. Patients who were followed up without surgery for blunt abdominal trauma, patients who underwent surgery for trauma other than blunt abdominal trauma, patients who underwent packing in an operation other than trauma surgery, and patients who underwent surgery for blunt abdominal trauma but did not receive packing were excluded from the study.

Demographic characteristics, vital parameters, cause of trauma, presence of additional injuries, laboratory and radiologic imaging, intraoperative findings, surgical intervention, duration of surgery, number of hospitalization days, mortality, and complications were retrospectively scanned through the hospital information management system and recorded on data forms. Shock Index (SI), Injury Severity Score (ISS), Revised Trauma Score (RTS), Trauma and Injury Severity Score (TRISS), and Glasgow Coma Scale (GCS) scores were calculated according to the data obtained from vital signs, radiological examinations, and consultation notes of other trauma branches [5]. The extent of liver and spleen injury was reported using the “Injury Scoring Scale” recommended by the American Association of Trauma Surgery (AAST) [6].

All patients were resuscitated according to advanced trauma life support guidelines from the time of admission to the emergency department. Sonographic evaluation in the emergency department - Focused abdominal sonography for trauma (FAST) - was performed by experienced emergency medicine specialists. All operations were performed by trauma surgery teams in the general surgery clinic. In cases with major liver injury, surgeons with experience in hepatobiliary surgery were also invited to the case. Post-discharge follow-up of patients without mortality was carried out in the outpatient clinics of the emergency surgery unit.

Surgical Technique

Informed consent forms for surgical procedures were signed by the patients and/or their relatives before surgery. Necessary safe surgical procedures were followed. Patients who underwent emergency laparotomy for blunt abdominal trauma were studied through a midline incision above and below the umbilicus. After rapid exploration, the procedure was started with four-quadrant packing, then the area with intense bleeding was identified, and interventions were performed for the injured organ. Although repairs or resections were performed in luminal organ injuries, anastomosis was not carried out in the first session. Splenectomy was performed if there was a high-grade injury to the spleen. Primary suturing, hemostatic agent, and/or packing were applied according to the extent of the injury in the liver. Interventions were managed according to the patient’s stability, depending on the status of injuries to other organs. After packing, the patients continued to be treated in the intensive care unit, and their general condition was expected to stabilize for depacking surgery within 24 to 48 hours.

Statistical Analysis

All data analyses were performed using the Statistical Package for the Social Sciences (SPSS, International Business Machines, New York, USA) version 25. Since the sample size of the study was smaller than 30 (n<30), the conformity of the data to normal distribution was examined by the Shapiro-Wilk test. Normally distributed data were expressed as mean and standard deviation (±SD). Data that did not show normal distribution characteristics were summarized with median, 1st quartile (25% value, Q1), 3rd quartile (75% value, Q3), and minimum and maximum (min-max) values. Nonparametric data were expressed as numbers (n) and percentages (%).

Ethical Approval

This study was approved by the Clinical Research Ethics Committee of Basaksehir Cam and Sakura City Hospital (Date: 2023-09-04, No:547).

Results

In our study, the data of a total of 15 patients, including 11 (73.3 %) males and 4 (26.7 %) females, were analyzed. The mean age of the patients was 36.13 ± 1 4.16 years. Although traffic accidents were the most common cause of blunt trauma in the mechanism of blunt trauma, blunt traumas in the form of impact and crushing due to occupational accidents ranked first with a rate of 33.3% in terms of subtypes (Table 1). Complete blood count, aspartate aminotransferase (AST), alanine aminotransferase (ALT) and other laboratory test results of the patients measured at the time of admission to the emergency department are given in Table 2 (Table 2). Median days of hospitalization was 14 (1-124) days. Mortality was observed

Table 1. Distribution of nonparametric data

			Mean ± Sd
Age			36.13 ± 14.16*
	Category		**N (%)**
Sex	Male		11 (73.3)
	Female		4 (26.7)
Mechanism of injury	Work accident (crush, jam, explosion)		5 (33.3)
	Traffic accident	Motorcycle	4 (26.7)
		In car	3 (20)
		Pedestrian	1 (6.7)
	Falling from height		2 (13.3)
Intra-abdominal injuries	Liver	isolated	7 (46.6)
		With additional injury	7 (46.6)
		Total	14 (93.3)
	Spleen		4 (26.6)
	Retroperitoneum (hematoma, hemorrhage)		3 (20)
	intestinal meso		3 (20)
	Kidney		2 (13.3)
	Pancreas		1 (6.6)
	Bowel		1 (6.6)
Additional extra-abdominal injuries	Extremity, vertebra, pelvis		6 (40)
	Thorax (contusion, hemopneumothorax), rib fracture		8 (53.3)
	Cranium(intracranial hemorrhage)		2 (13.3)
Liver injuries	None		1 (6.7)
	isolated left lobe (segment 2,3,4)		0
	isolated right lobe (segment 5,6,7,8)		9 (60)
	Both right and left lobe		5 (33.3)

	Mean ± Sd	Median (min - max)	Q1	Q3
Length of stay (days)		14 (1 - 124)**	7	27
Surgery time (minutes)	127 ± 48.13*			

* Normally distributed data **non-normally distributed data
Sd: ± standard deviation, min:mininum, max:maximum Q1: 25% quarter Q3: 75% quarter

Table 2. Laboratory tests and trauma scores

Parameters		Mean ± Sd	Median (min - max)	Reference range (Unit)	Q1	Q3
Laboratory tests	Lactate		5.6 (1.9-16)**	<1.5 mmol/L	2.9	10.3
	Wbc		14.7 (4.6-40)**	4.49 - 12.68 (10^9/L)	12.6	23.5
	Hct	34.3 ± 7.2*		36.6 – 44 (%)		
	Hgb	11.3 ± 2.4*		10.6-13.5 (g/dL)		
	Plt	228.6 ±79.7*		150 – 400 (10^9/L)		
	INR	1.3 ± 0.2*		0.8 -1.2 (INR)		
	CRP		1.5 (0.2-30.7)**	0.5-5 (mg/L)	0.5	9
	ALT	623.4 ± 475.9*		0 - 35 (U/L)		
	AST	687 ± 565.6*		10-35 (U/L)		
	LDH		880 (377-3187)**	0 – 250 (U/L)	569	1650
	Amylase		110 (30-335)**	28-100 (U/L)	48	126
	Lipase		112 (24-516)**	13-60 (U/L)	35	195
	Creatinine	1.3 ± 0.3*		0.5-0.9 (mg/dL)		
Scorings	SI		1.3 (1-2.8)**		1.2	1.9
	GCS		14 (3-15)**		6	15
	ISS	37.2±9.4*				
	RTS		6.1(2.6-7.8)**		4.5	7.8
	TRISS		75 (5.6-97)**		60	95

Table 3. Analysis of patients with mortality

N:3	Patient 1	Patient 2	Patient 3
Sex	**Male**	**Male**	**Male**
Age	21	39	52
Type of trauma	Work accident (crush)	Work accident (crush)	Work accident (explosion)
Injury sites	Retroperitoneum, meso, intestines, intracranial hemorrhage	Liver, retroperitoneum, hemopneumothorax	Liver, hemopneumothorax, intracranial hemorrhage
Depacking	No	No	Yes

in a total of 3 patients (20%). All patients were evaluated with FAST, and 13 patients (87.7%), excluding 2 patients, were imaged with both FAST and computed tomography.

Shock index, ISS, RTS, TRISS, and GCS values of the patients and the organs with injuries are presented in Table 3 (Table 3). Splenorrhaphy was successful in 4 patients (26.6%) with grade 2 lacerations, and splenectomy was performed in the other three patients with grade 4 injuries. One of the 14 patients (93.3%) with liver injury underwent non-anatomical right hepatectomy during depacking. In this patient and another patient with a large hematoma in segment 5, cholecystectomy was performed during depacking, and a catheter was placed in the cystic duct and removed from the abdomen. One of the two patients with renal injury was followed up. In the other, total nephrectomy was performed in the first session. The findings of the exitus patients are given in Table 4 (Table 4). Two patients with intracranial hemorrhage also had a mortal outcome. Sphincterotomy and stenting were performed by endoscopic retrograde cholangiopancreatography (ERCP) in a patient with a pancreatic fistula and in a patient who underwent liver repair and had a bile fistula through the drain.

Discussion

Our study includes the results of our practices in a three-year period in our hospital, a regional trauma center. In addition to being the largest trauma center in the region, our health facility is in a location with dense industrial facilities and a high population rate.

In a study involving patients presenting with abdominal trauma, the majority of whom were BAT (70.8%), the mean age was 36 years, and the proportion of males was 79%. [7]. The majority of the patients in our study were also male, and the mean age (36 ± 14) was below 45 years, consistent with the literature. Traffic accidents rank first in the etiology of blunt abdominal injuries, followed by falls and battery cases, respectively [8]. The most common cause of BAT in our study was traffic accidents, followed by occupational accidents and falls from height, respectively.

Radiographic imaging is an important part of the clinical examination in BAT. Focused abdominal sonography (FAST) for trauma is preferred as the first screening method after the primary evaluation in trauma algorithms for thoracoabdominal injuries [9]. However, due to various limitations caused by ultrasonography, computed tomography (CT) is considered the gold standard in trauma imaging evaluation. CT should only be performed under the supervision of the trauma team in patients who are hemodynamically stable or respond to fluid resuscitation [10]. All patients in our study underwent bedside FAST assessment at the time of presentation to the emergency department. Two patients with unstable general conditions and diffuse intra-abdominal hemorrhagic fluid detected by FAST underwent emergency surgery without a CT scan.

Since the most commonly injured organs in blunt abdominal trauma are the spleen and liver, it is crucial to perform complete blood count and liver function tests in laboratory tests. AST is initially higher than ALT due to rhabdomyolysis caused by blunt trauma. Newton et al. reported that ALT may be preferred as a screening tool for hepatic trauma [11]. Bilgic et al. suggested that patients with thresholds of ALT ≤76 U/L, AST <130 U/L had a low-grade liver injury and that these patients could be treated without surgery [12]. Similarly, high mean AST and ALT were associated with liver injury in our study.

With the establishment of trauma centers in many large healthcare facilities in recent years, patients with hemodynamically stable or treatment-stabilized trauma can be managed with nonoperative management (NOM) [13]. In patients with abdominal trauma, systolic blood pressure (SBP) less than 90 mmHg at the first examination in the emergency department is an important finding indicating the severity of injury and hemodynamic instability. Harvin et al. found SBP <90 mmHg in 23% of 1,706 patients who underwent emergency laparotomy in their study of 74,048 patients in 12 trauma centers over a two-year period. In the same study, the rate of damage control laparotomy was reported as 38% [14].

The Shock Index (SI), which is heart rate divided by SBP, may be a simple tool to identify patients with hemorrhagic shock. Four groups were defined as SI <0.6 (no shock), SI ≥0.6 to <1.0 (mild shock), SI ≥1.0 to <1.4 (moderate shock), and SI ≥1.4 (severe shock) [15]. In our study, the mean SBP of the patients was below 90 mmHg, the pulse rate was above 100/min, and the mean SI was 1.3, which was in the moderate shock category.

As reported in various studies in the literature, the liver is one of the most common organ injuries secondary to trauma. Therefore, the treatment strategies to be applied in trauma-related liver injury should be thoroughly familiarized. According to the World Society of Emergency Surgery (WSES) liver trauma management guidelines, in laparotomy, in the absence of major bleeding, compression alone, electrocautery, bipolar devices, topical hemostatic agents, or simple suturing of the liver parenchyma may be sufficient to stop bleeding [10]. However, in case of rapid deterioration of hemodynamics and high blood loss during surgery, perihepatic tamponade (packing) should be performed. Hemostasis is aimed to be achieved by compression between the tampons placed above and below the bleeding parenchyma [16]. It is recommended to avoid hepatic resections in the treatment of unstable patients and during damage control procedures. Despite this, hepatic resection may be required in 2-4% of cases of major liver trauma [10]. In the liver injuries in our study, mainly bipolar cauterization, primary suturing, and packing using hemostatic agents were performed, and hepatic resection during DCS was not used in any patient. During the depacking procedure, one patient underwent a right hepatectomy due to completely circulatory compromised liver segments.

Trauma scoring systems are a common means to facilitate the assessment of injury severity and comparison of treatment outcomes. The most commonly used scoring systems include the Glasgow Coma Scale (GCS), Injury Severity Score (ISS), Revised Trauma Score (RTS), and Trauma and Injury Severity Score (TRISS). The ISS score is the most common anatomical scoring system utilized for patients with multiple injuries. Duration of hospitalization is associated with morbidity and mortality [5]. Bolorunduro et al. divided ISS into four groups as mild (<9), moderate (9-15), severe (16-25), and profound (>25) [17]. The mean ISS we calculated was 37.2 ± 9.4, and all patients were in the riskiest group. The most common injury accompanying abdominal trauma was thorax trauma with a rate of 53%.

Due to its low sensitivity and specificity, ISS cannot distinguish between survivors and non-survivors. Instead, it has been suggested that RTS and TRISS can be used to predict the survival rates of trauma patients [18]. In our study, the ISS was above 40 points in all three patients with mortality, while both RTS and TRISS values were significantly lower in two of them compared to the surviving patients.

The timing of emergency laparotomy is one of the most important prognostic factors in patients with major trauma and hemodynamic instability. Although there is no strict time limit for emergency laparotomy, the American College of Surgeons Committee on Trauma (ACS-COT) recommends intervention within 120 minutes [19]. Although DCS contributes to decreased mortality, it also carries complications such as sepsis, abscesses, biliary fistulas, abdominal compartment syndrome, gastrointestinal fistulas, and abdominal hernias [20, 21]. Minor bile duct injuries often heal spontaneously within 14 days and do not require any intervention, but major bile duct injury or persistent bile leaks can be treated with ERCP and biliary stent drainage. Biliary complications rarely require surgical treatment except in cases of failure of conservative treatment or uncontrolled sepsis [22]. In our study, we performed cholecystectomy and transcystic catheter placement through the cystic duct in a depacking procedure in two patients. Furthermore, one patient who underwent only liver repair needed stenting with ERCP due to a biliary fistula in the postoperative period. Similarly, a patient with pancreatic fistula required ERCP. As we applied packing to all patients in our study, no fascia closure was performed as a temporary abdominal closure method, and only skin closure was performed. No signs of abdominal compartment syndrome were observed in any of our patients.

Although NOM has become a frequently used method in trauma centers in recent years, mortality is also observed in these patients. Even in high-volume trauma centers, the overall mortality rate in the treatment of trauma patients was reported to be 10% [23]. It was reported that in-hospital mortality was 10.9% in primary surgical treatment patients and 3.6% in NOM patients, while the mortality rate in primary surgery cases was 23.8% in patients with combined hepato-spleen injury [24]. In our study, no combined liver-spleen injury was observed in the patients with mortality. However, the presence of retroperitoneal bleeding or intracranial bleeding was noted in these patients. Talih et al. reported that ISS level, hypotension, and hemorrhagic shock on admission were significant risk factors for mortality in their study in which the mortality rate was found to be 47% [25]. Although DCS in trauma aims to reduce mortality, studies indicating that high complications were observed in survivors were also reported. Roberts et al. reported that there were significant differences between the indications for DCS in different trauma centers and that there were unnecessary referrals to this procedure. There is a growing number of studies examining admissions to DCS due to its high complicative consequences [20]. Lack of information about the causes of trauma and the patient can negatively impact surgical decision-making, leading to less effective clinical choices. Therefore, it is important to determine which patient should be treated with which treatment protocol. For this reason, the concept of teamwork emerges.

In addition to being a major trauma center, the structure and dynamics of emergency trauma teams are determined by an in-house protocol. In fact, a division of labor within the team has been determined for emergencies that may cause a large number of trauma patients to apply, such as earthquakes, mass traffic accidents, and explosions. Having a trauma team contributes greatly to making joint treatment decisions for patients and taking the best decision.

Limitation

Our study had several limitations due to its retrospective and single-center design. Since we retrospectively scanned through the “packing” code in the surgical record system, we were able to screen only patients who underwent damage control surgery and packing. Therefore, we could not screen patients who were followed nonoperatively or underwent damage control surgery without packing. This led to the lack of a control group in our study. Although the number of patients in the study seems to be limited, we think that it is significant in terms of reflecting our packing results in our hospital, which has a level 1 trauma center.

Conclusion

Despite all the advances in the nonoperative management of patients with blunt abdominal trauma, damage-control laparotomies remain an effective procedure in the management of severe trauma in a group of patients with massive bleeding and coagulopathy. It is possible to achieve acceptable mortality and morbidity rates with trauma surgery teams experienced in damage control surgery. Furthermore, establishing well-equipped trauma centers and managing the process with a multidisciplinary approach are among the most crucial factors in increasing the success rates of trauma surgeries.

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Scientific Responsibility Statement
The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and Human Rights Statement
All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or compareable ethical standards.

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Conflict of Interest
The authors declare that there is no conflict of interest.

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